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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION V

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SUBJECT: Preliminary Ecological Assessment of Pullman Factory, Chicago, Illinois

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The following report summarizes preliminary findings regarding potential ecological risk at the Pullman Factory Site (the site). The findings are based on the Expanded Site Inspection Final Report (ESI) prepared by B&V Waste Science and Technology Corp. for the U.S. EPA, November 29, 1994. The objectives of this review are to identify ecological resources, and possible immediate or long term ecological threats the site may pose.

## 1. Problem Formulation

### 1.1 Environmental Setting

#### 1.1.1 Site Description

Pullman Factory was used as a sewage farm operation between 1881 and 1907. The site is now a residential area of southeast Chicago bound by Indiana and St. Lawrence Avenues and 130th and 134th Streets. It received untreated industrial and domestic sewage, and possibly liquid waste from the Calumet Paint Company. The Little Calumet River is close to the southern and western sides of the site.

#### 1.1.2 Sensitive Habitats

Palustrine wetlands were identified from the Lake Calumet wetlands map. The nearest wetland borders 130th Street immediately north of the site, and consists of approximately 16 acres (6.5 ha) of impounded seasonally flooded deciduous forest and emergent vegetation wetlands. Similar wetlands extend about 0.6 mi to the east along the north side of 130th Street, but do not directly border the site. Two 20-acre (8-ha) wetlands are located within 0.5 mi of the site: a seasonally flooded emergent vegetation wetland to the northwest among the railroad tracks, and a temporarily flooded mixed forest and emergent vegetation wetland to the east of the site (south of Carver Park). The Little Calumet River is adjacent to the southern boundary of the site, and curves around to within 250 yd of the northwest corner of the site. Two deciduous forest palustrine wetlands are located about 0.5 and 0.8 mi downstream. The former, with about 0.14 mi river frontage, is on the north bank between the river and the rail spur south of 127th Street, and is temporarily flooded. The latter, with approximately 0.5 mi river frontage, is on the south bank west of the rail bridge, part of the Whistler Preserve, Cook County Forest Preserve District, Riverdale, and is seasonally flooded.

### 1.1.3 Endangered Species

Lake Calumet, about 1.5 mi northeast of the site, contains black-crowned night herons, double-crested cormorants, great egrets and great blue herons. The former three species are listed as state threatened. The foraging distance of great blue herons ranges from 1 to 5 mi or more (USEPA 1993), and therefore may include the Little Calumet River adjacent to and downstream from the site. The same is probably true of the other species. Other state-listed birds at Lake Calumet include common moorhens, pied-billed grebes, least bitterns, black terns, and yellow-headed blackbirds. A substantial colony of double-crested cormorants also is established in Riverdale.

The site is a residential neighborhood and therefore does not possess suitable on-site habitat for the aforementioned species, or for any other endangered species.

## 1.2 Chemicals of Potential Ecological Concern

### 1.2.1 Chemicals at the Site

Twenty-three soil samples were collected between January 19 and 25, 1994, for the ESI (including one background sample, SS01). Six of the samples (SS16-SS20 and SS22) were collected from adjacent off-site properties. Sample depths ranged between 6 and 16 inches below the surface. The chemicals elevated above background concentrations are as follows (the number following the chemical is the number of samples with detections exceeding background):

total xylene (1), phenanthrene (1), anthracene (1), carbazol (1), di-n-butylphthalate (1), fluoranthene (1), pyrene (1), benzo[a]anthracene (1), chrysene (1), bis(2-ethylhexyl)phthalate (DEHP) (2), benzo[b]fluoranthene (1), benzo[k]fluoranthene (1), benzo[a]pyrene (1), indeno [1,2,3-cd]pyrene (1), 4,4'-DDE (4), 4,4'-DDD (1), 4,4'-DDT (3),  $\alpha$ -chlordane (1), As (1), Ba (3), Pb (1), Mn (1), Ag (2), Tl (2), V (1), and cyanide (1).

Mn and V are eliminated as chemicals of potential concern (COPC) because the detections are within the ranges reported for soils in the U.S. (Table 1). Ag and Tl are eliminated because the detections (0.58 and 2.2 mg/kg, respectively) are below the CRQLs. DHEP would normally be eliminated from further consideration because it is a common laboratory contaminant and was detected in the blank; however, the concentration in one sample (8900  $\mu$ g/kg) is elevated about 20 times above background and therefore is retained as a COPC.

**Table 1. Elements Detected in Concentrations Equivalent to Literature-Reported Background and Therefore Eliminated as Chemicals of Potential Concern, Pullman Factory, Chicago, IL.**

Element	Maximum Detection <sup>a</sup>	Average <sup>b</sup>	Range <sup>b</sup>
	----- (mg/kg) -----		
Mn	1200	560	1 - 7000
V	69	76	<7 - 500

a) ESI 1994.

b) Shacklette et al. 1971.

### 1.2.2 Fate, Transport, and Ecotoxicity

Only those chemicals likely to contribute to the potential ecological risks of the site are discussed in this section. This procedure is followed because the preliminary ecological risk assessment (PEA) is based on a screening comparison of the concentrations of COPC with benchmark guidelines by media. The benchmark values are sufficiently conservative so that chemicals detected at concentrations below the guidelines are not expected to exhibit significant ecological effects, even if fully bioavailable. Since fate, transport and toxicity variables do not modify the outcome of the screening (these effects are embedded in the derivation of the particular guidelines), discussions of these processes for the chemicals screened out are unlikely to contribute meaningful information to the PEA.

The following COPCs are likely to contribute to the potential ecological risks of the site (section 2.3):

On-site samples - Ba and Pb;

Off-site samples - phenanthrene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, total PAHs, DDE, total DDT analogues, As and Ba.

Adsorption of PAHs in soil is directly proportional to soil organic matter (OM) content and the  $K_{ow}$  of the PAH (greater in high molecular weight (HMW) PAHs than in low molecular weight (LMW) PAHs), and is inversely proportional to soil particle size (roughly 2 orders of magnitude greater on silts and clays as compared with sands). LMW PAHs have higher volatilization rates and are more readily leached as compared with HMW PAHs. Both LMW and HMW PAHs are microbially degraded, but the rates are higher for the former probably because of weaker adsorption and greater bioavailability. Examples of soil half-lives are approximately 100-200 and 300-500 days for LMW and HMW PAHs, respectively; however, they will be longer in hazardous waste sites toxic to bacteria. Plants absorb PAHs from soil, especially LMW PAHs, and readily translocate them to above-ground tissues. The concentrations in plants are substantially lower than in soil, and they are poorly correlated because of deposition and absorption of atmospheric PAHs. Foliar herbivory does not appear to be a

significant route of exposure to soil PAHs. Bioaccumulation has been shown in terrestrial invertebrates and voles, earthworm levels were 30-60 times greater than soil concentrations (Gile et al. 1982), but PAH metabolism is sufficient to prevent biomagnification. The oral toxicity of PAHs ranges from very to moderately toxic (50 to 1000s mg/kg bw) in rats. Many PAHs are carcinogenic, producing tumors in epithelial tissues in "practically all animal species tested" (Eisler 1987). Other effects in terrestrial organisms are poorly characterized, but may include adverse effects on reproduction, development, and immunity (ATSDR 1993c).

DDT and its metabolite DDE are highly persistent and lipophilic compounds subject to pronounced biomagnification. The extremely low water solubilities result in strong adsorption to soil particles and very low leaching losses. The main physical causes of attenuation of soil DDT are volatilization (estimated half-life of 100 days) and erosion. Microbes biodegrade DDT to DDE and DDD under aerobic and anaerobic conditions, respectively. Both metabolites are more persistent than DDT. Plants absorb DDT and its metabolites from soil, but they are poorly translocated and remain primarily in the roots. Foliar herbivory is therefore not a significant route of exposure to soil DDT. The toxicity of DDT to earthworms is low (Edwards and Bohlen 1992), so bioaccumulation by earthworms is a significant route of exposure to vermivores and can result in lethal doses (Barker 1958). DDT and DDE are moderately toxic to rodents with oral  $LD_{50}$ s in the low to high 100s mg/kg bw. However, DDT is a cumulative poison, and the chronic lethal dose may be substantially less than the acute lethal dose, for example, the chronic minimum lethal dose in mallards is 50 mg/kg bw/day, only 2% of the acute  $LD_{50}$  (Tucker and Crabtree 1970). DDT is a neurotoxin that affects the central nervous system by increasing neurotransmitter release, disrupting neural ion regulation, and inhibiting neural ATPase activities. Symptoms include excitability, tremors, convulsions and death. Chronic effects are of greater significance for higher organisms than acute effects. DDT adversely affects avian and mammalian reproduction by eggshell thinning, infertility, and embryo- and fetotoxicity. The effects may be related to the estrogenic activity of o,p'-DDT and o,p'-DDE. DDT and DDE are also carcinogenic in rodents (ATSDR 1994).

As exists in four valence states, of which the pentavalent ( $As^{+5}$ ) and trivalent ( $As^{+3}$ ) are more prevalent. The former predominates in aerobic conditions, the latter in anaerobic ones.  $As^{+3}$  is more soluble and mobile than  $As^{+5}$  which adsorbs to clay, organic matter, Ca and hydroxides. Soil As is depleted by leaching losses and microbial conversion of inorganic As into volatile arsine compounds. The estimated half-life of soil As ranges from 6 to 16 years. As is phytotoxic, causing growth reductions, leaf wilt and discoloration. The soil concentrations associated with 90% growth inhibition vary greatly with soil conditions, ranging from 100 to 1000 ppm in sandy and clayey soils, respectively. Plants readily absorb soil As and translocate it to above-ground tissues, but it is only moderately bioaccumulated and poisoning of herbivores is "believed to be very uncommon" (Kabata-Pendias and Pendias 1992). As does not biomagnify. As is extremely toxic with single dose oral  $LD_{50}$ s in the low 10s mg/kg bw for sensitive avian and mammalian species.  $As^{+3}$  inhibits enzymes by reacting with protein sulfhydryl groups - a major effect of which is to interfere with oxidative metabolism.  $As^{+5}$  is less

toxic than  $\text{As}^{+3}$ , but is capable of uncoupling oxidative phosphorylation. As is carcinogenic in humans, but has not been shown to be carcinogenic in animals. The primary ecotoxicological concerns relate to acute and subacute exposures. Chronic effects are rarely observed in wildlife because of rapid detoxification (methylation) and excretion (ATSDR 1993a, Eisler 1994).

Ba does not occur in a pure form in the environment because of its reactivity. Ba has low mobility in most soils because it readily forms insoluble carbonate and sulfate compounds, adsorbs to clay and organic matter, and reacts with metal oxides and hydroxides which then adsorb to soil particles. Mobility increases in sandy soils with low cation exchange capacity, in acidic soils, and in the presence of Cl, acetate or nitrate because barium salts are more soluble than other Ba compounds. Ba is taken up by plants, especially in acidic soils, and is commonly present in agricultural products in 10s to low 100s ppm, but has the lowest bioaccumulation of any trace element ( $10^{-3}$  plant/soil concentration ratio) (Kabata-Pendias and Pendias 1992). The ecotoxicological properties of Ba are not well characterized. It is moderately toxic to rats with an oral  $\text{LD}_{50}$  in the low 100s mg/kg bw/day. There are conflicting reports of chronic adverse cardiovascular and developmental effects in rats at 5 to 18 mg/kg bw/day, respectively, and indications of dermal and ocular irritation, but the studies are poorly documented (ATSDR 1992). The primary risks to terrestrial wildlife are associated with direct exposure, most likely through incidental soil ingestion and fossorial activities.

Pb is relatively immobile in moderately acidic to basic soils ( $\text{pH} > 5-6$ ) with soil organic matter (OM) contents of at least 5% due to sorption to OM, ion exchange with clays and hydrous oxides, chelation with humic substances, and formation of insoluble organic lead complexes. Leaching is very slow except under acidic conditions ( $\text{pH} < 4-6$ ), or low OM content ( $< 5\%$ ), or when Pb concentrations exceed the soil cation exchange capacity. The main loss of soil Pb is by erosion (ATSDR 1993b). Soil Pb is relatively unavailable to plants, except under acidic conditions, and the majority of the absorbed Pb is retained in the root system. Phytotoxicity is rarely observed, probably because of the low availability to plants and internal immobility (Kabata-Pendias and Pendias 1992). The poor translocation of Pb to above-ground plant tissues also means that foliar herbivory is not a major route of exposure to soil Pb, and that plant growth will not attenuate soil Pb levels. Earthworms do not bioaccumulate inorganic Pb except under highly acidic conditions, so the main route of exposure for vermivores is incidental soil ingestion (including the soil in the worm guts) (Beyer 1990). The toxicity of inorganic Pb to earthworms is low, with LOAELs greater than 5000 and 50,000 mg/kg soil for inhibition of reproduction and growth, respectively (Edwards and Bohlen 1992). Shrews accumulate Pb to a greater extent than voles or mice, and estimated Pb intake on contaminated sites may approach the LOAEL for rodent reproductive effects (low to mid 10s mg Pb/kg bw/day) (Shore and Douben 1994). Pb poisoning of birds has been associated with ingestion of lead shot and bioaccumulative organolead compounds, but not with food chain exposure to inorganic Pb. There are complex interactions with other contaminants and diet. Pb poisoning in higher organisms primarily affects hematologic and neurologic processes. Potential endpoints include growth reductions and impaired survival (Eisler 1988).

### 1.2.3 Exposure Pathways and Potential Receptors

The primary route of exposure to the COPC is direct, through vermivory, incidental soil ingestion, or burrowing. DDT and DDE are the only COPC that biomagnify. The potential receptors are restricted to common urban/suburban wildlife such as robins, rodents or moles.

## 2. Preliminary Analysis of Ecological Risk

### 2.1 Ecotoxicological Benchmark Values

The preliminary ecological risk assessment (PEA) is based on a screening comparison of the concentrations of COPC with benchmark guidelines by media. The following (nonregulatory) guidelines are used in this PEA:

Netherland Soil Cleanup (Interim) Act (Beyer 1990);  
Soil Cleanup Criteria for Quebec (Beyer 1990).

### 2.2 Exposure Estimates

The PEA is performed with the following conservative assumptions:

Bioavailability - 100%;

Area use factor - 100%;

Contaminant level - highest sample concentration.

### 2.3 Risk Characterization

Comparisons of the concentrations of COPC with benchmark guidelines are given in Table 2. Soil quality criteria (SQC) were not located for 4 COPC: carbazole, di-n-butylphthalate, benzo[b] fluoranthene, and benzo[k] fluoranthene, all of which were detected in the same off-site sample (SS20) that contains the PAHs in Table 2. The risks of these COPC are not separately considered since evaluation of the PAHs should adequately characterize potential ecological risks at that location. An ecologically-based soil criterion for DEHP was not located, but a comparison is made with human health-based soil cleanup goals. The maximum DEHP detection is 1 to 3 orders of magnitude below these goals, which may be taken as presumptive evidence that significant ecological effects are unlikely.

Ba and Pb are the only on-site COPC that meet the SQC. They probably do not present significant ecological risks for the following reasons: 1) the acute toxicities are low, 2) they do not biomagnify, 3) they are well below ground (8-14 inches for Ba, and 10-16 inches for Pb), 4) they do not bioaccumulate in above-ground plant tissues, and 5) there are few detections (section 1.2.1).

Table 2. Comparison of Soil Contaminant Data with Nonregulatory Soil Quality Criteria, Pullman Factory, Chicago, IL.

Substance	SQC <sup>a</sup>		Maximum Detect <sup>b</sup>	HQ <sup>c</sup>	
	B	C		B	C
	----- (mg/kg) -----				
Total xylene	5	50	0.01	0.002	
Phenanthrene <sup>d</sup>	5	50	21	4	0.4
Anthracene <sup>d</sup>	10	100	3.5	0.4	
Fluoranthene <sup>d</sup>	10	100	23	2	0.2
Pyrene <sup>d</sup>	10	100	22	2	0.2
Benzo [a] anthracene <sup>d</sup>	1	10	9.7		1
Chrysene <sup>d</sup>	5	50	12	2	0.2
Benzo [a] pyrene <sup>d</sup>	1	10	9		1
Indeno [1,2,3-cd] pyrene <sup>d</sup>	1	10	4.6	5	0.5
Total PAHs <sup>d</sup>	20	200	123.7 <sup>e</sup>	6	0.6
DEHP <sup>f</sup>	70	5000	8.9	0.1	
4,4' -DDE <sup>d</sup>	0.5	5	0.58	1	0.1
4,4' -DDD	0.5	5	0.078	0.2	
4,4' -DDT <sup>d</sup>	0.5	5	0.37	0.7	
Total DDT analogues <sup>d</sup>	1	10	0.95	1	0.1
$\alpha$ -chlordane	0.5	5	0.014	0.03	
As <sup>d</sup>	30	50	33.1	1	0.7
Ba	400	2000	2590		1
Pb	150	600	270	2	0.5
Cyanide	10	100	6.4	0.6	

a) The Soil Quality Criteria (SQC) are based on the Netherland Soil Cleanup (Interim) Act and the Soil Cleanup Criteria for Quebec (Beyer 1990). Criteria B refer to moderate soil contamination that requires additional study. Criteria C refers to severe soil contamination.

b) ESI 1994.

c) Hazard Quotient (HQ) = sample concentration  $\div$  SQC, and rounded to one significant digit.

d) Detected in off-site property.

e) The total includes benzo [b] fluoranthene and benzo [k] fluoranthene.

f) The SQC are based on human health as approved by the Ontario Ministry of the Environment for on-site cleanup goals of former oil refineries (Beyer 1990). The lower and upper range of acceptable soil concentrations are given under criteria B and C, respectively.

The same reasoning and conclusion apply to the off-site As and Ba. The remaining off-site exceedances, DDE and total DDT, and PAHs are unrelated to site operations. DDT was manufactured after site operations ceased. The PAHs exceedances all occur in a single sample, which appears to be an isolated hot spot, possibly caused by household dumping of a petroleum product. The DDE/DDT exceedance also occurs in a single sample.

## 2.4 Uncertainty

Risks are intentionally overestimated by the conservative assumptions discussed in section 2.2, and by the use of generic benchmark values. The main uncertainty is that concentrations at the surface are unknown.

## 3. Conclusions and Recommendations

The site does not present a significant potential ecological risk. The few contaminants that meet soil guidelines, Ba and Pb, have low acute toxicity to soil invertebrates, mammals or birds; have little potential for bioaccumulation; are located well below the surface; are not bioaccumulated in above-ground plant tissues; and were detected in only a few samples. There appears to be little potential for erosion or leaching and discharge into the Little Calumet River, but, even if there were, the concentrations reaching the river would be well below those of potential ecotoxicological concern.

The isolated hits of DDE/DDT and PAHs are of greater potential concern, however, the former is definitely and the latter probably unrelated to the site. Each appears to be a local application or spill.

There are no ecological grounds for further consideration of the site under Superfund.

I may be contacted at 6-7195 if you have questions or comments. Please fill out the attached evaluation form and return it to Steve Ostrodka, HST-6J. The information is used to assess and improve our services.

cc: Steve Ostrodka, Chief, TSS  
William Muno, Director, WMD

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